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ABSTRACT

The present study assessed the effects that the density of an array has on two aspects of memory: the ability to recall a group of items and the ability to place these items in their original locations. First-graders, fourth-graders, and college students were asked to memorize 16 common objects presented in either a dense array or a spaced array. After performing a filler task, subjects were asked to recall the objects and then were given the objects to replace in their original locations. Recall scores were higher than replacement scores at all ages and for both dense and spaced conditions. No differences were found between genders. An interaction was found between recall score and density of presentation. First- and fourth-graders recalled the dense array better than the spaced, but college students recalled the spaced array better. The younger children's better performance on the recall of dense arrays was discussed in relation to their visual search strategies during the memorization period. (Author/RH)

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The Effects of Density of Array on The Development of Recall and Replacement Abilities

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Abstract

The present study assessed the effects that the density of an array has on two aspects of memory: the ability to recall a group of items and the ability to place these items in their original locations. First-graders, fourth-graders, and college students were asked to memorize 16 common objects presented in either a dense array or a spaced array. After performing a filler task, subjects were asked to recall the objects and then were given the objects to replace in their original locations. Recall scores were higher than replacement scores at all ages and for both dense and spaced conditions. No differences were found between genders. An interaction was found between recall score and density of presentation. First- and fourth-graders recalled the dense array better than the spaced, but college students recalled the spaced array better. The younger children's better performance on the recall of dense arrays was discussed in relationship to their visual search strategies during the memorization period.

The Effects of Density of Array on

The Development of Recall and Replacement Abilities

The present study was undertaken to assess the development of two aspects of memory: the ability to recall a group of items and the ability to place these items in their original locations. In addition, the present study assessed the effects that the density of an array has on these two aspects of memory. Thayer (1984) investigated "the effect of inter-item distance on the recall and replacement of items" (p. 2) by college students. Thayer initially reported that analyses of the total number of items correctly recalled and replaced yielded no significant effects related to gender or spacing. However, Thayer did find that in females, but not males, the density of items in an array had an effect on which areas of the array were recalled and replaced most accurately.

Utilizing a modification of Thayer's (1984) methodology, the present study assessed the effects of the density of an array on recall and replacement in a cross-sectional sample. The major questions addressed were: 1) are the abilities of recall and replacement acquired developmentally? 2) Do the abilities of recall and replacement have similar developmental trends? 3) Does density of an array affect these abilities? And, 4) are there gender differences in these abilities?

Method

Subjects

Sixty-one first-graders (30 males, 31 females), 58 fourth-graders (28 males, 30 females), and 60 college students (30 males,

30 females) participated in the present study. The elementary school subjects were from a south-central Pennsylvania school district and participated after consent had been obtained from both the parents and the school district. The college students were enrolled in a small liberal arts college and participated as part of a course requirement in Introductory Psychology.

Procedure

Subjects were shown 16 common objects and were asked to name them. The objects used were a button, nail, eraser, stamp, watch, die, plastic shamrock, ring, paper clip, poker chip, rubberband, bandaid, match, playing piece, key, and penny. If a subject could not name an object, they were told what the object was and were again asked to name it. Objects were presented on either a 17 by 17 (the dense condition) or 24 by 24 (the spaced condition) centimeters cardboard square and arranged so that 8 objects formed an outer circle and 8 formed an inner circle. Subjects participated in either the dense or the spaced condition.

After naming the objects, subjects were given one minute to memorize the objects. The objects were removed and the subjects performed a filler task (working on a puzzle of the United States) for three and one-half minutes. Subjects were then asked to name all the objects they could recall. Next, subjects were given the 16 objects and asked to place them in their original locations on a cardboard square equal in size to the original square they were shown.

Results

Initial analyses were conducted to determine whether or not differential results based on gender existed. No significant differences were found in the present study between males and females at any age on any of the abilities measured. Because of this finding, all subsequent analyses were performed using groups composed of both genders. With the exception of college students in the spaced condition, recall scores were higher than replacement scores at all ages and for both dense and spaced conditions (see Table 1). College students in the spaced condition showed a similar, but nonsignificant, trend.

Insert Table 1 about here

As shown in Figure 1, a developmental trend was found for recall of both dense and spaced arrays. Recall of spaced arrays improved significantly between each of the age groups. Recall of dense arrays showed significant improvement only between first and fourth grade, with fourth-graders approximating the college students' abilities. An interaction was found between recall score and density of presentation. First- and fourth-graders recalled the dense array better than the spaced, $\underline{t}(59) = 4.56$, $\underline{p} < .001$, and $\underline{t}(56) = 3.67$, $\underline{p} < .001$, respectively. However, college students recalled the spaced array better than the dense, $\underline{t}(58) = -2.62$, $\underline{p} < .05$.

Insert Figure 1 about here

As shown in Figure 2, a developmental trend was also found for replacement abilities of both dense and spaced arrays. Both conditions had similar developmental sequences, with fourth-graders performing better than first-graders, and college students performing better than either first- or fourth-graders. While there were no significant differences between dense and spaced conditions on replacement scores with either first- or fourth-graders, college students had significantly higher replacement scores on the spaced condition, $t(58) = -2.10$, $p < .05$.

Insert Figure 2 about here

Discussion

Answering the major questions that were addressed by the present study: 1) both the ability of recall and the ability of replacement were found to be acquired developmentally. 2) These abilities did show similar, but not identical, developmental trends. While improvement was seen between all ages in replacement scores, recall scores showed a similar trend only in the spaced condition. Fourth-graders' recall scores in the dense condition approximated the performance of college students. 3) Density of array did affect both recall and replacement abilities. And, 4) no differences in these abilities or the development of these abilities was found between genders.

The elementary school children's better performance on the recall of dense as opposed to spaced arrays may be related to their visual search strategies during the memorization period. Macworth and Bruner (1970) found, in an experiment recording eye fixations, that children in first grade had shorter search patterns and relied less on peripheral vision than college students. Vurpillot (1968) also reported that younger children had a restricted scanning pattern when compared to older children. Perhaps the closeness of objects in the present study's dense condition allowed the younger children to fixate on more objects during the memorization period, hence aiding memory. An informal analysis of the spaced condition data appears to support this contention. The first-graders recalled and replaced more objects from the inner circle (which was denser) than from the outer circle in the spaced condition, providing preliminary support for the assertion that the dense array aided memory by allowing the children to fixate on more objects during the memorization period. Conversely, the college students' better performances on spaced arrays as opposed to dense arrays may have resulted from their use of broader search patterns.

The finding of no differences in overall abilities in either condition or at any age related to gender is consistent with Thayer's (1984) results with college students and the general findings in the related literature. The question of the interaction between gender, spacing, and recall or replacement of selected areas of the arrays was not addressed in the present analyses. Future analysis of the current data may provide a

comparison, across ages, with Thayer's finding that in females density did affect which areas of the array were recalled and replaced most accurately.

In conclusion, the finding that density does have an affect on recall and replacement abilities and that this affect differs depending on the age of the subjects tested, coupled with the finding of developmental trends in the observed memory abilities, suggests that to optimize recall the density of visually presented material may need to be modified relative to subjects' ages. In particular, with younger children, where the popular convention is to present material in spaced arrays, the present research suggests that the use of dense presentations of material may be beneficial.

References

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Table 1

Comparison of Mean Recall and Replacement Scores

Group	Array	Recall	Replacement
First Grade	Dense	7.70	2.90**
First Grade	Spaced	6.16	4.48**
Fourth Grade	Dense	10.45	6.62**
Fourth Grade	Spaced	8.90	6.69**
College	Dense	10.93	9.67*
College	Spaced	12.10	11.17

* $p < .05$

** $p < .001$

FIGURE 1

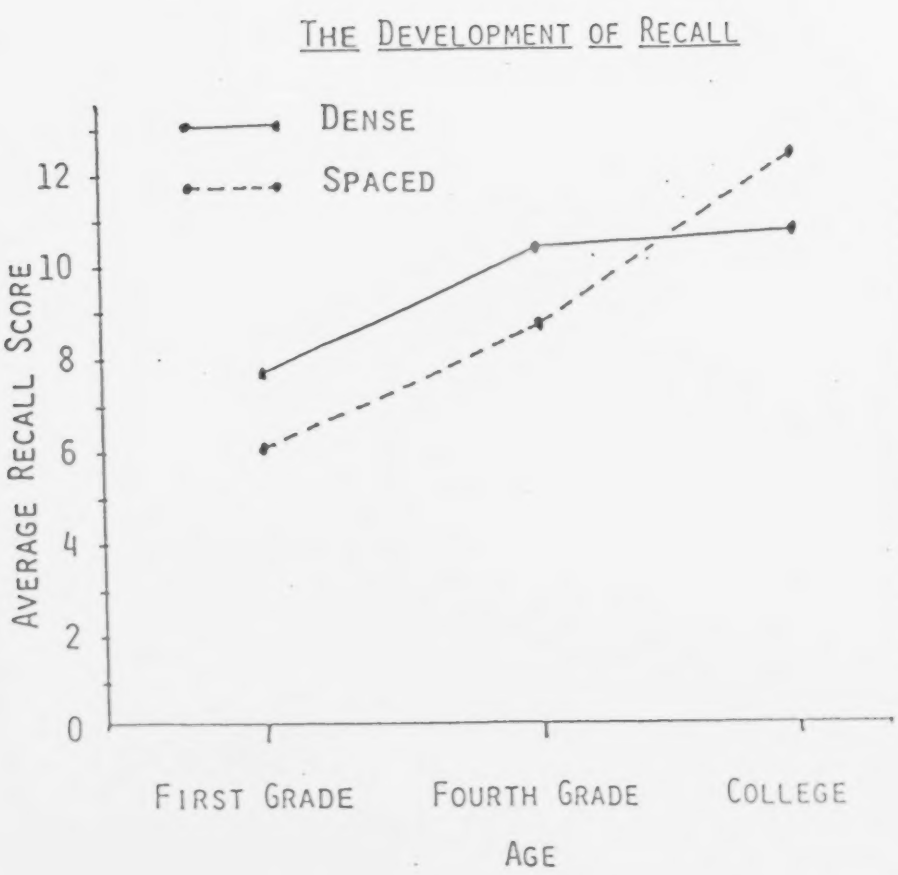

FIGURE 2